***GTA 05-02-013**

How To Find Your Way

Purpose: This graphic training aid (GTA) explains and illustrates the fundamentals of map reading. The information conforms as closely as possible to approved Department of the Army (DA) doctrine and is intended to complement existing training literature. Refer to Field Manual (FM) 3-25.26 for more information.

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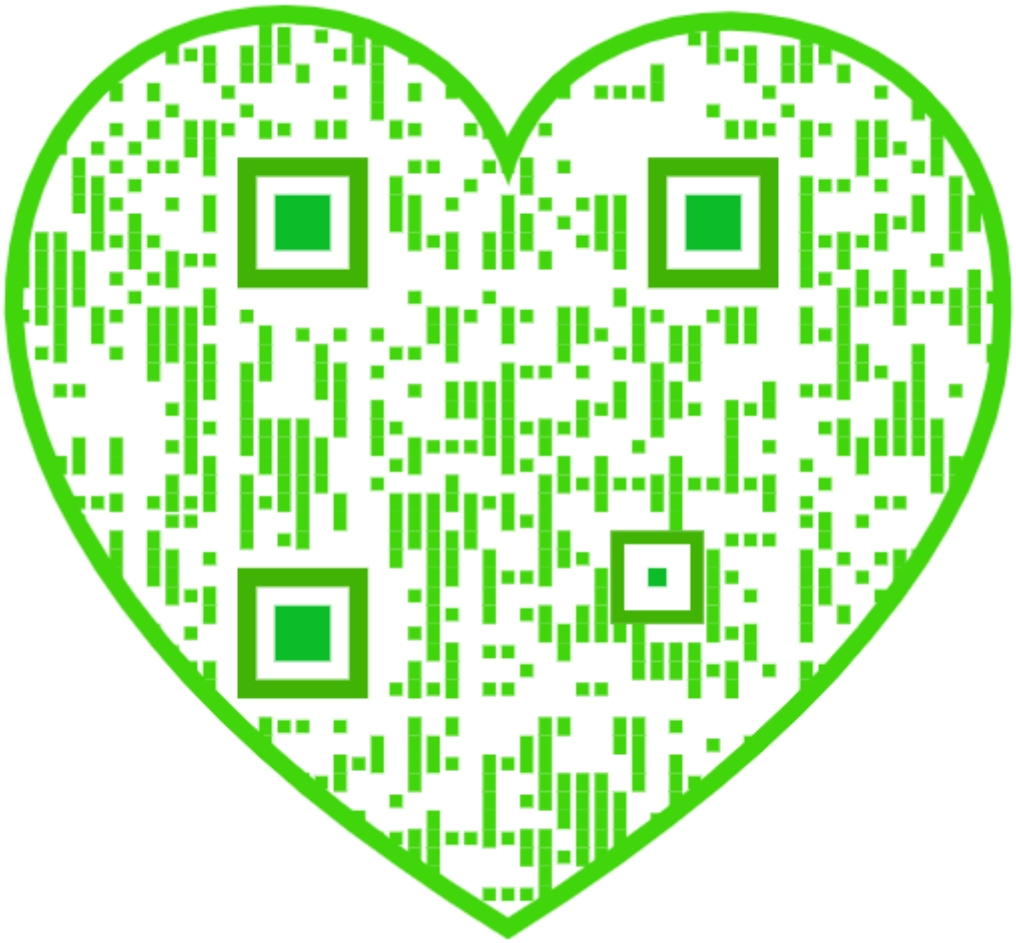

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INTRODUCTION

When you get lost in combat, you may encounter the enemy, fail your mission, and have trouble getting back to your unit. To avoid getting lost, use—

- A map.
- A compass.
- Other ways to find directions.
- Common sense.

You will learn what you need to know about military maps and direction finding so that you can move about with confidence without getting lost. A map is nothing more than a drawing of a section of the earth's surface as you would see it if looking straight down from an airplane.

Maps show man-made objects, such as roads, buildings, and bridges. All of these man-made objects are represented by a symbol. The symbols are explained in the legend, located at the lower left-hand corner of every map (Figure 1).

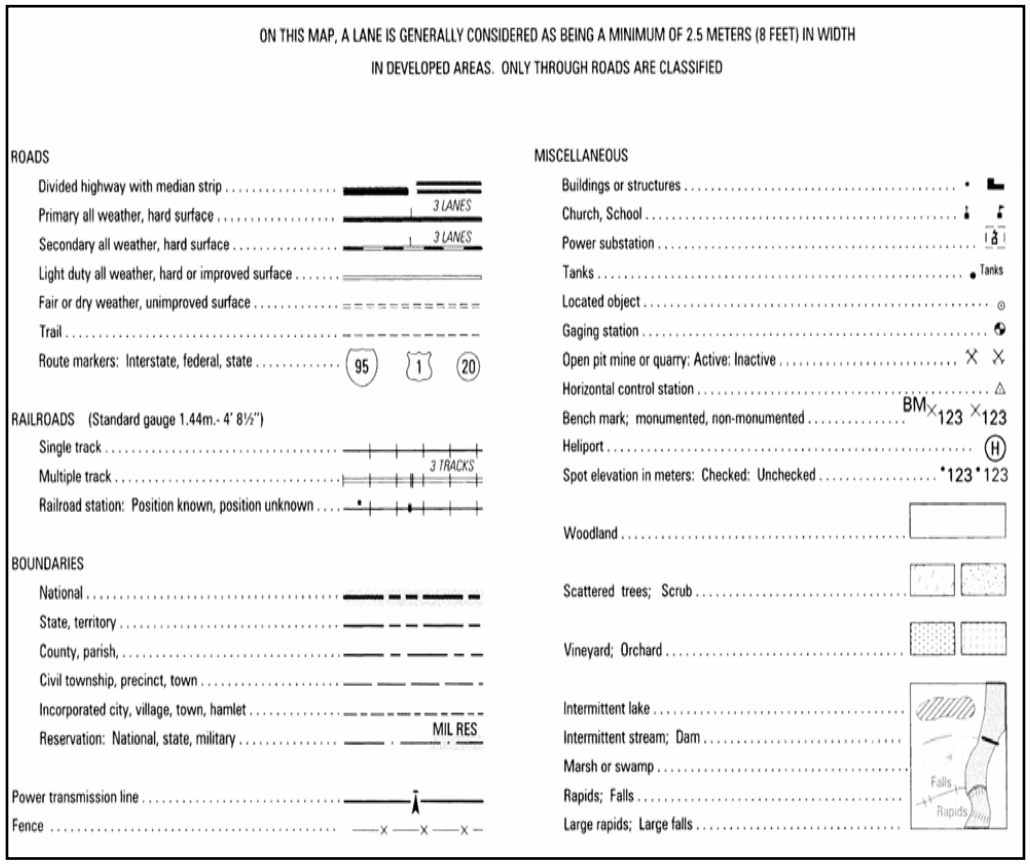

Figure 1. Sample Map Legend

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Besides giving symbols for man-made objects, the legend gives the color coding used on the map and explains the meaning of other symbols, which gives you a better idea of what the ground actually looks like. Always look at the legend before using your map.

FINDING YOUR LOCATION

To avoid getting lost, you have to know how to find your location. There are no street addresses in a combat area. However, by using a military map, you can find your location without difficulty. Maps have black lines running up and down (north and south) and crosswise (east and west). These lines form small squares called "grid squares" that are numbered along the outside edge of the map picture. Using these numbers, you can identify each grid square.

No two squares have the same number. To get the right numbers for a certain grid square, read from left to right along the bottom and locate the line that borders the grid square on the left. Then read up, and find the east-west line that borders the grid square along the bottom (Figure 2).

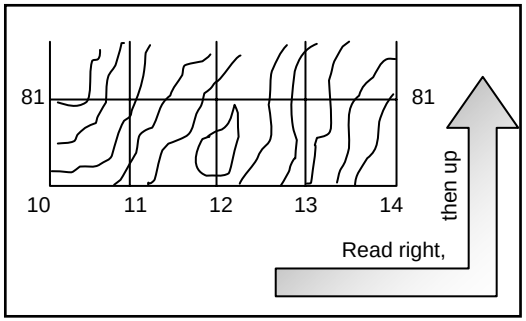

Figure 2. Map Grid Squares

Figure 3 shows your location as grid square 1181. How do you know this? Start from the left and read right until you come to 11, and then read up to 81. Your location is somewhere in the grid square of 1181. Remember to read from left to right, then up.

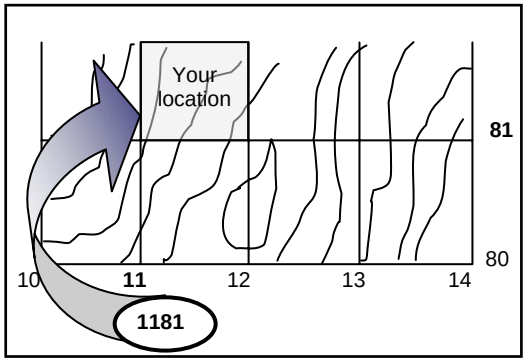

Figure 3. Grid-Square Location

Grid square 1181 gives your general location, but there is a lot of area inside that grid square. To make your location even more accurate, you will need to add another number to the first half and another to the last half.

To get these numbers, imagine that each grid square has ten lines inside it running north and south, and another ten lines running east and west. This makes 100 small squares (Figure 4). You can estimate where these imaginary lines are.

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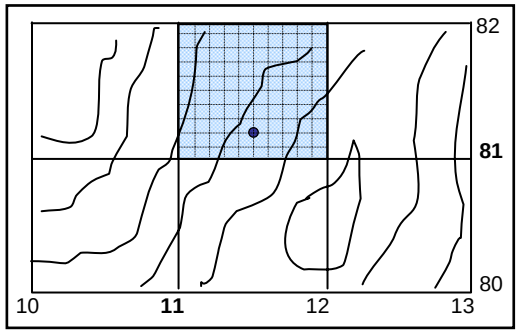

Figure 4. Grid-Square Coordinates

If you are exactly halfway between line 11 and line 12, your first added number is 5 and the first half of your location is 115. And suppose that you are also two tenths of the way between line 81 and line 82. Then the second half of the number is 812. If you were exactly on line 81, the second half would be 810.

Figure 4 shows that if you were located where the dot is in grid square 1181, your location would be 115812. These six numbers are called your "coordinates." They give your location, and if you always know your coordinates, you can never be lost.

If you have GTA 05-02-012 (Figure 5), you do not have to worry about estimating where you are inside a certain grid square or use imaginary lines. You can determine your exact coordinates.

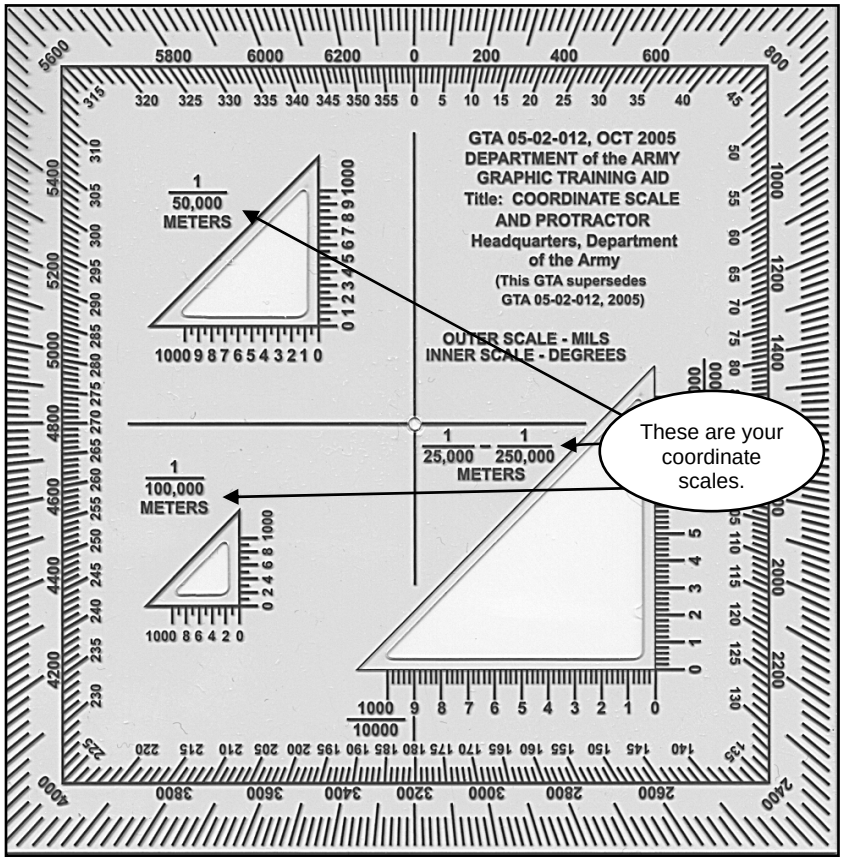

Figure 5. Coordinate Scale and Protractor

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The coordinate scale and protractor is a square piece of clear, thin plastic—called a "protractor" for short. The protractor helps to measure small distances inside grid squares. You can also measure angles with it. You will learn more about measuring angles later. Your squad leader can show you exactly how to use the protractor.

DETERMINING THE DISTANCE

You can use your map to measure the distance between two places, because maps are drawn to scale. This means that a certain distance on the map equals a certain distance on the earth. This scale is printed at the bottom and top of a map (for example, *Scale 1:50,000*). This signifies that 1 inch on the map equals 50,000 inches on the ground. Any ground distance equals 50,000 times that distance on the map.

NOTE: Always check the scale on your map before trying to measure distance, because different maps have different scales.

Two methods used to determine distance are the—graphic (bar) scale method and the pacing method.

Graphic (Bar) Scale Method

There are three different bar scales at the bottom of your map. Use these scales to help convert the map distance into miles, meters, or yards. To figure the distance on the ground using the graphic (bar) scale method, take the edge of a piece of paper and put a tick mark on it at the straight-line distance between your two points (Figure 6). Then put the paper beneath one of the bar scales and read the ground distance in miles, meters, or yards. For example, the estimated ground distance on the bar scale between the marks in Figure 6 is about 3,950 meters.

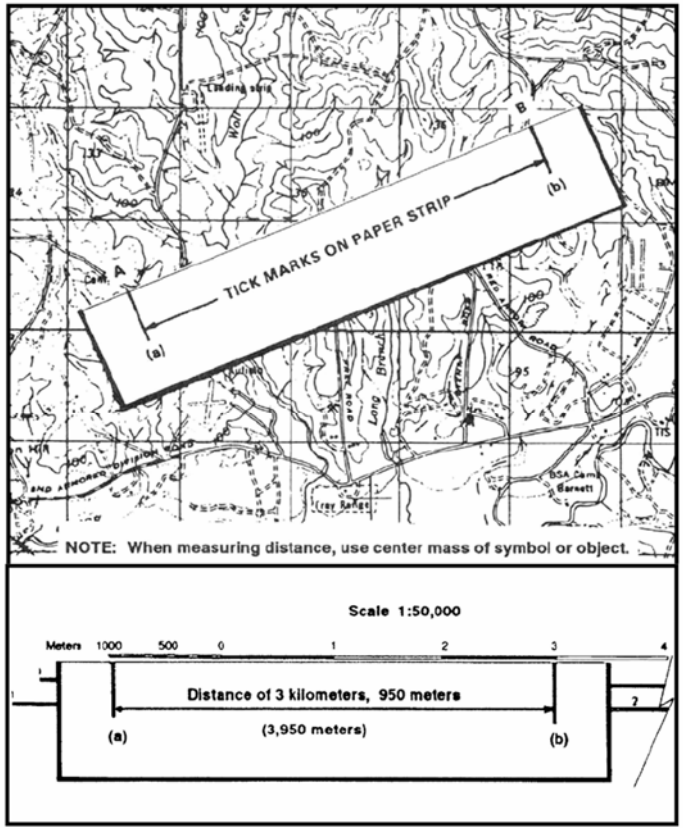

Figure 6. Finding Straight-Line Distance Using Bar Scales

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Suppose you want to find the distance between point A and point B around a curve in a road (Figure 7). Take a strip of paper, make a small tick mark on it, and line up the tick mark with point A. Align the paper with the road's edge until you come to a curve, make another tick mark on the paper and on the map, then pivot the paper so it continues along the road's edge. Repeat this until you get to point B, always following along the road's edge with your paper. Make a mark on your paper at point B, then go to the bar scales to find the distance.

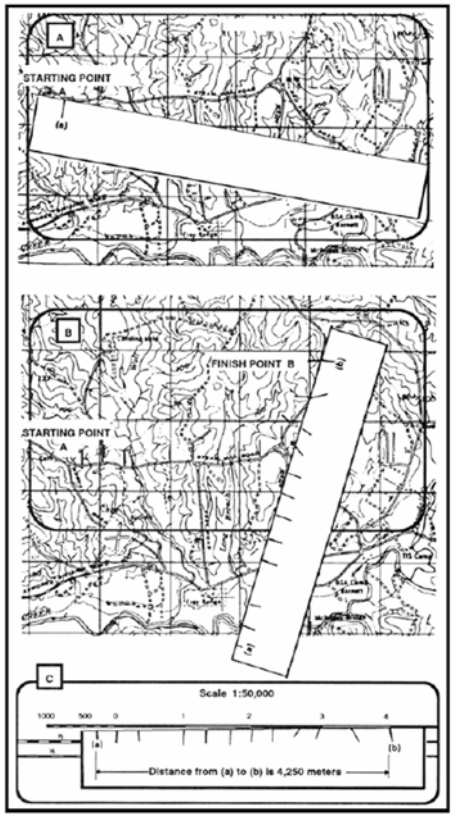

Figure 7. Finding Distance Around Curves Using Bar Scales

Pacing Method

When you have to go a certain distance on foot without any landmarks to guide you, you can measure distance pretty accurately by counting your paces. The average pace is just a little less than 1 meter. The average person uses 116 paces to travel 100 meters.

NOTE: If you do not take 116 paces for 100 meters, determine how many paces you do take by pacing yourself on a known 100-meter distance.

When traveling cross-country, as you do in the field, you will use more paces to travel 100 meters—usually about 148 instead of 116. This is because you are not traveling over level ground and must use more paces to make up for your movement up and down hills. Pace yourself over at least 600 meters of cross-country terrain in order to learn how many paces it takes you to travel an average 100 meters. Be sure you know how many paces it takes you to walk 100 meters on both level and cross-country terrain.

The big problem with pacing is maintaining a straight line. At night, the average person tends to walk in a circle when not using a compass. During the day, you should use a compass and steering points (well-defined objects in your direction of travel). Also, remember to figure only the straight-line distance when you have to walk around an obstacle.

Another problem with pacing is keeping count of the paces that you have taken. One way to keep count is to use pebbles. For instance, suppose you want to pace off 1 kilometer (1 kilometer is 1,000 meters or the distance between two of the black grid lines on your map). Put 10 pebbles in your right pocket. When you go 100 meters, move one pebble to your left pocket and start your count over.

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When all 10 pebbles have been moved to your left pocket, you have traveled 1 kilometer. Another way to keep count is by tying knots in a string—one knot per 100 kilometers.

FINDING THE CORRECT DIRECTION

You have learned how to find your location (map coordinates) and how you can use the map scale to determine the distance. The next step is to find the correct direction. Knowing how to find these three things will keep you from getting lost.

Azimuth

The top of the map is north, the right is east, the bottom is south, and the left is west. The direction from one point to another point (either on the map or on the ground) is called an azimuth.

Azimuths are given in degrees in a clockwise direction. Since there are 360° in a circle, your azimuth can be any number up to 360°. Due east is 90°, due south is 180°, due west is 270°, and due north is 360° (Figure 8).

To get the right azimuth from a map, you have to use a protractor. If your coordinate is 220850 and you want to find the azimuth to a certain road junction, draw a line from your location to the road junction. Then place the protractor as shown in Figure 9.

Be sure to line it up properly, keeping the cross-center lines of the protractor parallel with the grid lines. The azimuth as shown by the protractor is 223°. Suppose you follow the 223° azimuth to the road junction, and then you want to go back to your original location. To do this, you must take a back azimuth. Simply subtract 180° from the first azimuth (223° - 180° = 43°).

If your first azimuth it is too small to subtract 180°, just add 180°. For example, if your azimuth was 40°, you know that you cannot

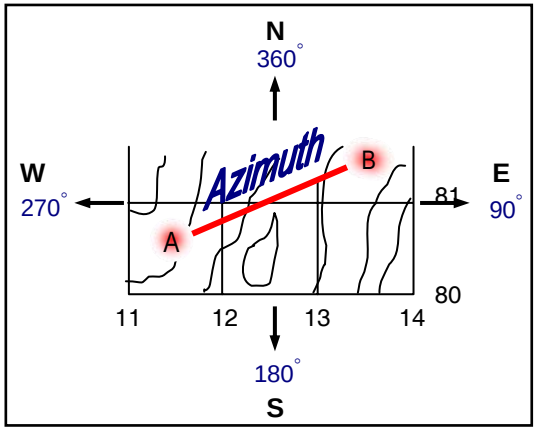

Figure 8. Azimuth

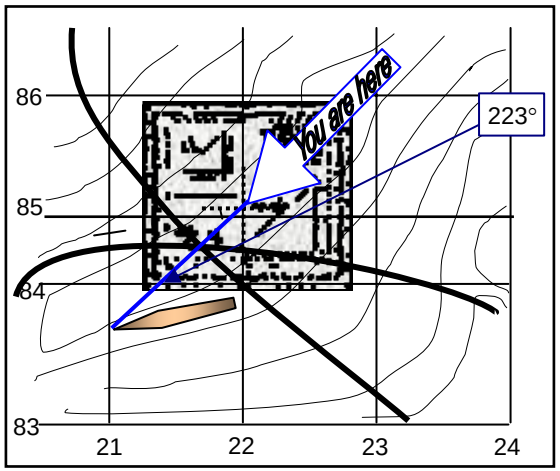

Figure 9. Finding Azimuths With a Protractor

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subtract 180° from it, so add 180° (40° + 180° = 220°). Remember, a back azimuth goes in the opposite direction from the azimuth.

CAUTION

When converting azimuths to back azimuths, use extreme care when adding or subtracting the 180°. A simple mathematical mistake could have disastrous consequences.

North

The north-south lines on a map give grid north. The compass needle points to magnetic north. Grid north and magnetic north usually have a few degrees difference. Neither points straight at the North Pole—that is called "true north." However, it is not necessary to know where true north is to avoid getting lost in a combat area.

The difference in degrees for every map between grid north and magnetic north is shown at the bottom of the map (Figure 10). This difference is called the "G-M angle" (Figure 11). The diagram at the bottom of newer maps shows how to change grid azimuths to magnetic azimuths and magnetic azimuths to grid azimuths.

For example, you aim your compass at a distant tower and get a compass reading of 190° (Figure 12). This is called a magnetic azimuth. The diagram on the map shows that the G-M angle is 2°. To convert the magnetic azimuth to a grid azimuth, add the G-M angle of 2° to the compass reading of 190°. This gives you a grid azimuth of 192°. Most of the time, the G-M angle is so small that you do not have to be concerned with it. It depends on what region of the world you are in. Your squad leader will tell you if the G-M angle in your area is large enough to be concerned with.

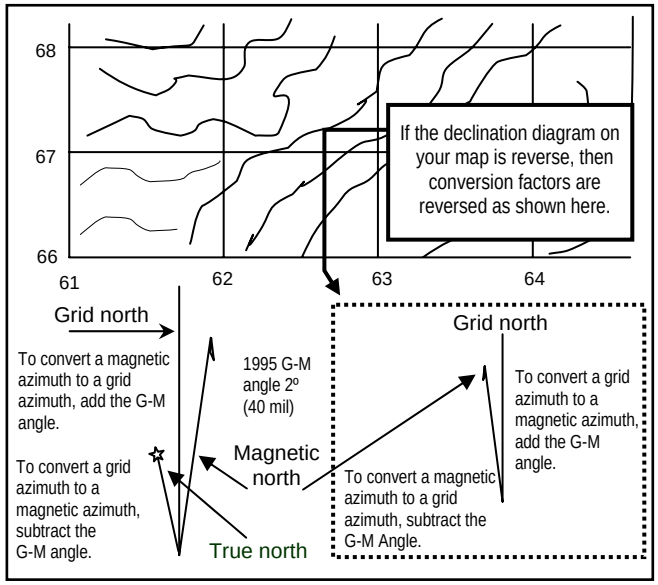
68
67
66
61
62
63
64
If the declination diagram on your map is reverse, then conversion factors are reversed as shown here.
Grid north
To convert a magnetic azimuth to a grid azimuth, add the G-M angle.
1995 G-M angle 2º (40 mil)
Magnetic north
To convert a grid azimuth to a magnetic azimuth, subtract the G-M angle.
True north
Grid north
To convert a grid azimuth to a magnetic azimuth, add the G-M angle.
To convert a magnetic azimuth to a grid azimuth, subtract the G-M Angle.

Figure 10. North

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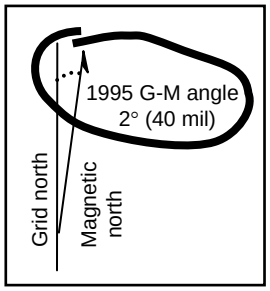

Figure 11. G-M Angle

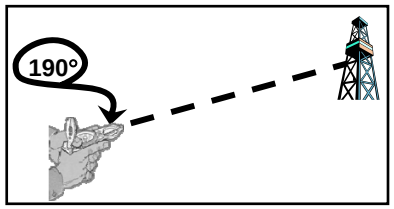

Figure 12. Magnetic Azimuth

Compass

Use your compass to find or follow an azimuth. The compass arrow points toward magnetic north. The arrow is also attracted by any mass of metal (such as a jeep, a truck, your rifle, your helmet, and even electrical power lines). Avoid any metal objects to get correct readings when using your compass. To shoot an azimuth, use the center-hold technique (Figure 13). It is faster, easier, and more accurate than the old sighting method. You can also use this method at night.

First, open the compass so that the cover forms a straight edge with the base. Move the lens of the compass out of the way. Place your thumb through the thumb loop, form a steady base with your third and fourth fingers, and extend your index finger along the side of the compass. Next, place the thumb of your other hand between the eyepiece and the lens, extend your index finger along the other side of the compass and your remaining fingers around the fingers of your other hand, and pull your elbows firmly into your sides. This puts the compass between your chin and your belt.

To measure an azimuth, turn your entire body toward the object, pointing the compass cover directly at the object. Once you are pointing at the object, simply look down and read the azimuth from beneath the fixed black index line.

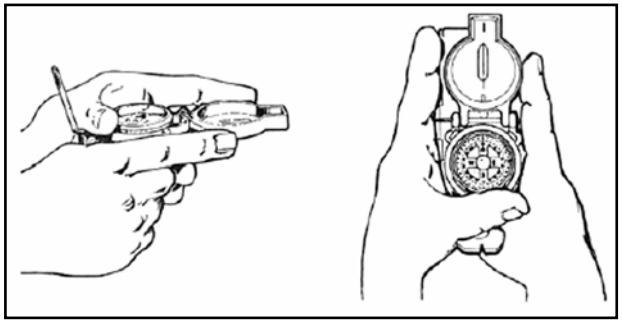

Figure 13. Center-Hold Technique

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If you are land navigating, stop occasionally to check the azimuth along which you are moving to keep from going in circles. You can move from object to object along your path of travel by shooting an azimuth to each object and then moving to that object. Repeating this process while you navigate should keep you on a straight path.

It is important to know your compass. The lensatic compass shown in Figure 14 is the most common and simplest instrument used for measuring direction. Your compass is a sensitive instrument and care should be taken in its use and handling.

The lensatic compass shown has luminous lines and dots. The bezel ring is a ratchet device that clicks when turned. All of these features are built into the compass to help you set an azimuth and follow it at night. How to keep your compass on course at night takes a little know-how. Your squad leader will assist you with all you need to know, or refer to FM 3-25.26 for more information.

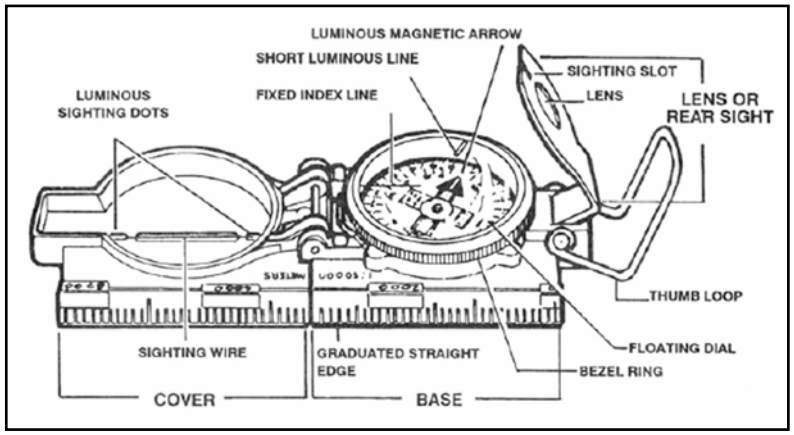

Figure 14. Lensatic Compass

OTHER TECHNIQUES OF FINDING DIRECTION

There are other techniques of finding your direction when you do not have a compass. These include the—

- Compass-to-cheek technique.
- Shadow-tip field-expedient technique.
- Watch technique.
- Star technique. 5

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Compass-to-Cheek Technique

The compass-to-cheek technique is used almost exclusively for sighting, and it is the best technique for this purpose.

Step 1. Fold the cover of the compass containing the sighting wire to a vertical position.

Step 2. Fold the rear sight slightly forward.

Step 3. Look through the rear sight slot, and align the front sight hairline with the desired object in the distance.

Step 4. Glance down the dial through the eye lens to read the azimuth (Figure 15).

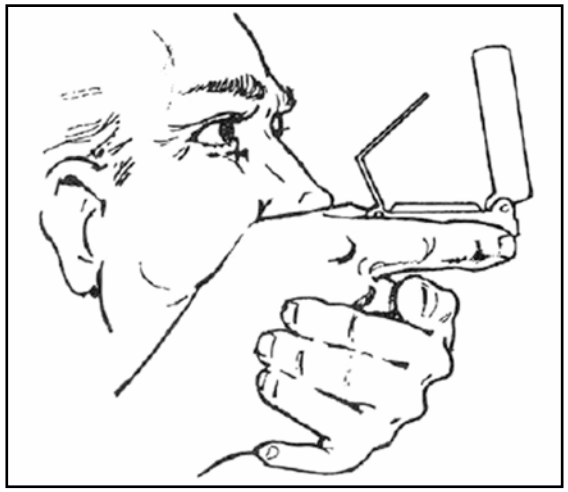

Figure 15. Compass-to-Cheek Technique

Shadow-Tip Field-Expedient Technique

The old rule that "the sun rises in the east and sets in the west" is a pretty good rule, but it is not quite right. Very seldom does the sun lie due east (exactly 90°) or due west (exactly 270°) on the horizon. Where exactly it does rise and set depends on where you are on the earth's surface and also on what time of year it is. In the morning, the sun rises almost east and in the afternoon it sets almost west. However, you can still use the sun to find direction by using the shadow-tip field-expedient technique, which is quick, easy, and very accurate (Figure 16).

Step 1. Place a stick or branch in the ground at a level spot where a distinctive shadow will be cast. Mark the shadow tip with a stone, twig, or other means. This first shadow mark is always west.

Step 2. Wait 10 to 15 minutes until the shadow tip moves a few inches. Mark the new position of the shadow tip in the same way as the first. This second shadow mark is always east.

Step 3. Draw a straight line through the two shadow-tip marks to obtain an approximate west-east line.

Step 4. Draw a north-south line perpendicular to the west-east line. Stand with the first mark (west) to your left (Figure 17). The other directions are north to the front, east to the right, and south behind you.

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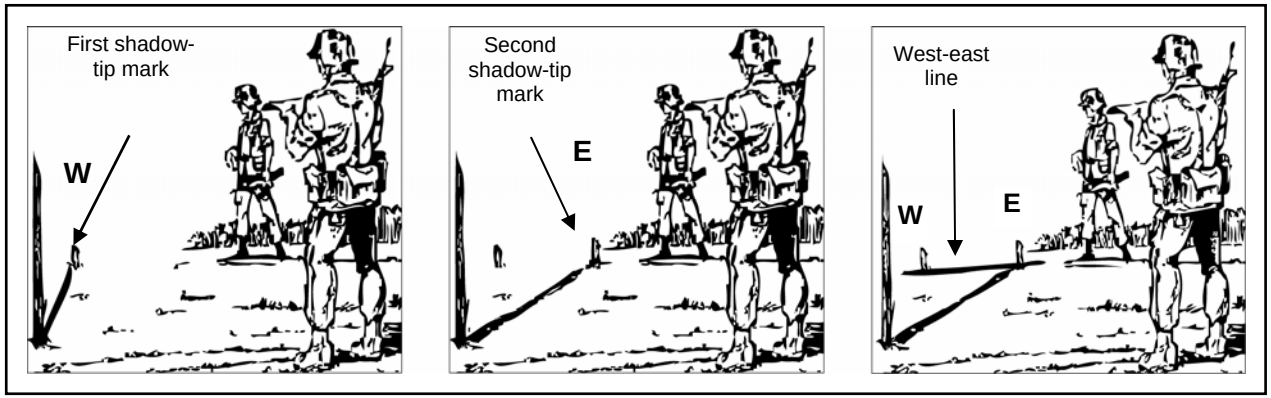

Figure 16. Shadow-Tip Field-Expedient Technique

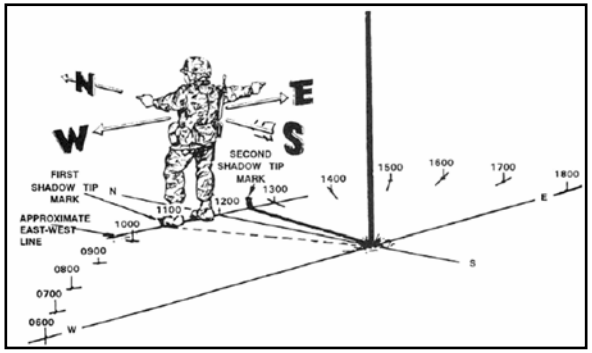

Figure 17. North-South Line

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Watch Technique

You can use your watch to determine the approximate true north and true south. However, it is not as accurate as the shadow-tip technique.

- **North temperate zone.** Point the hour hand toward the sun (Figure 18). Your south line is midway between the hour hand and 1200 hours, standard time. If on daylight saving time, the north-south line is found between the hour hand and 1300 hours.
- **South temperate zone.** Point the 1200 hour toward the sun. Midway between the 1200 hour and the hour hand will be your north line (Figure 19). If on daylight saving time, the north line lies midway between the hour hand and 1300 hours.

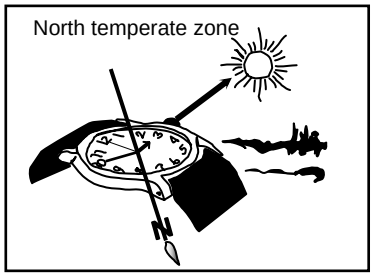

Figure 18. North Temperate Zone

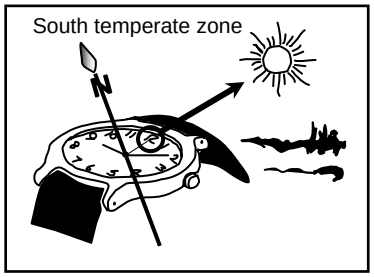

Figure 19. South Temperate Zone

NOTE: If there is any doubt to which end of the line is north, remember that the sun is in the east before noon and in the west after noon.

Star Technique

At night, you can locate north by finding the North Star (also called Polaris) (Figure 20). First, find the Big Dipper. The last two stars of the dipper's cup point directly at Polaris. Polaris is about five times as far out as the distance between those two stars. Facing Polaris, you are looking north, with east on your right and west on your left.

Once you are able to find north (using your compass, the sun, your watch, or the stars), you are ready to locate your position on the map. There are many good ways to locate your position on the map. First, you need to do one important thing—orient your map.

NOTE: Your map must be oriented so that north, south, east, and west on the map point the same way as they do on the ground.

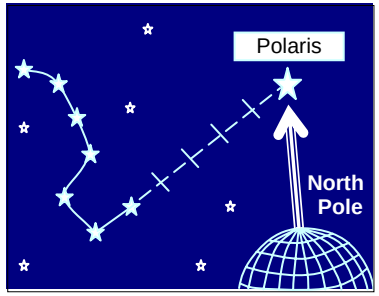

Figure 20. Polaris

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FINDING YOUR POSITION

Resection

Use resection to locate your position when you do not know exactly where you are.

Step 1. Orient your map as closely as possible.

Step 2. Look for a feature, such as the water tower (Figure 21 [A]), that you can find on the map.

Step 3. Put a ruler (or anything with a straightedge) on the map, and place its edge right next to the water tower symbol on the map (B).

Step 4. Align the ruler so that it points exactly at the real water tower.

Step 5. Draw a line along the ruler (the line will cross the water tower symbol on the map).

Step 6. Find another feature, such as the road junction (Figure 22 [C]), and do the same thing.

When you lay the ruler on the map and point it at the real road junction, its edge crosses over the road junction on the map (D). Draw another line along the ruler until it crosses (intersects) the first line. The point where the lines intersect is your location. This procedure is called resection. A third line may help you locate your position more accurately. Remember to not move your map once you have it properly oriented.

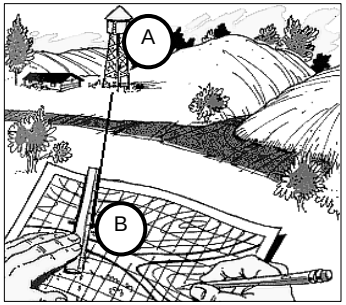

Figure 21. Water Tower

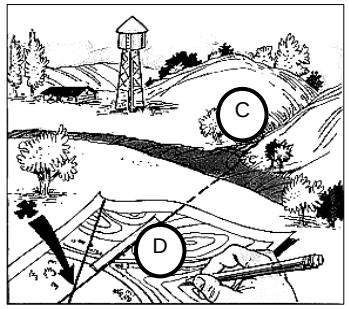

Figure 22. Road Junction

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Modified Resection

If you know that you are located somewhere along a certain linear feature on the map, such as a road or riverbank, then you can use a method called modified resection to pinpoint your location. This is an easier method to use.

Step 1. Orient your map**.**

Step 2. Locate a feature that you can also find on the map, such as the water tower in the previous example.

Step 3. Put a straightedge through the water tower symbol on the map and align the straightedge so that it points exactly at the real water tower.

Step 4. Draw a line along the ruler. The point where the line crosses the linear feature you are on is your location. If you do not have a regular straightedge, you can use something such as your rifle cleaning rod, a section of radio antenna, or even the edge of a C-ration box.

NOTE: Always orient your map as closely as you can—using your compass is the best way.

Figure 23 shows another way of using resection and modified resection to locate your position even closer than what you have just learned.

Step 1. Use your compass to shoot azimuths to your reference points, such as the water tower and the road junction.

Step 2. Convert the magnetic azimuths to grid azimuths.

Step 3. Determine the grid back azimuths, and plot them on your map.

Your position is where these grid back azimuths intersect. For more details on this method, ask your squad leader or refer to FM 3-25.26.

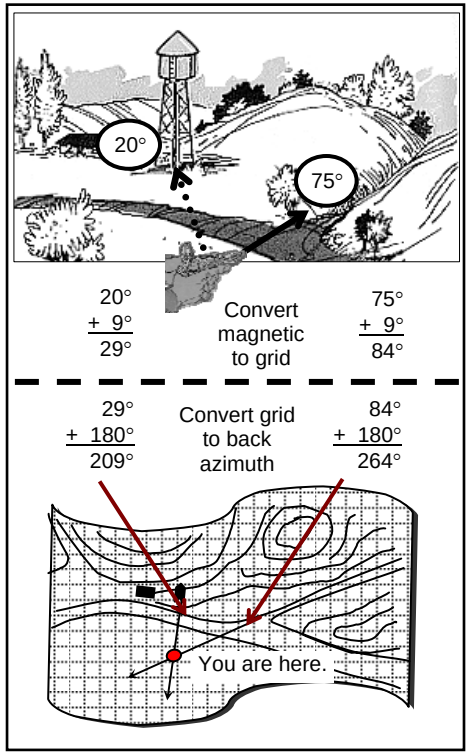

Figure 23. Calculating Azimuths

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Intersection

Suppose you want to find the location of a certain object that you can see in the distance, such as an enemy observation post (OP), but it is not on your map (Figure 24). Use the intersection method as follows:

Step 1. Shoot an azimuth to the object using your compass. If you have to, convert the magnetic azimuth to a grid azimuth.

Step 2. Draw a line on the map from your location along the grid azimuth that you came up with. The enemy OP lies somewhere along this line.

Step 3. Move to another location where you can observe the same enemy OP or have another friendly element located somewhere else (who also sees the enemy OP) shoot an azimuth to it (Figure 25).

Step 4. Convert the azimuth from magnetic to grid, and draw it on your map (out from the point where the azimuth was taken).

The enemy OP lies where the second line intersects with the first line.

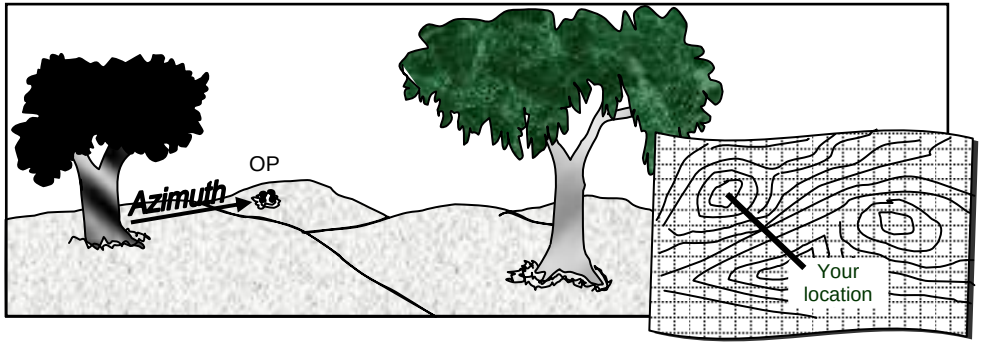

Figure 24. Intersection Process – Step 1

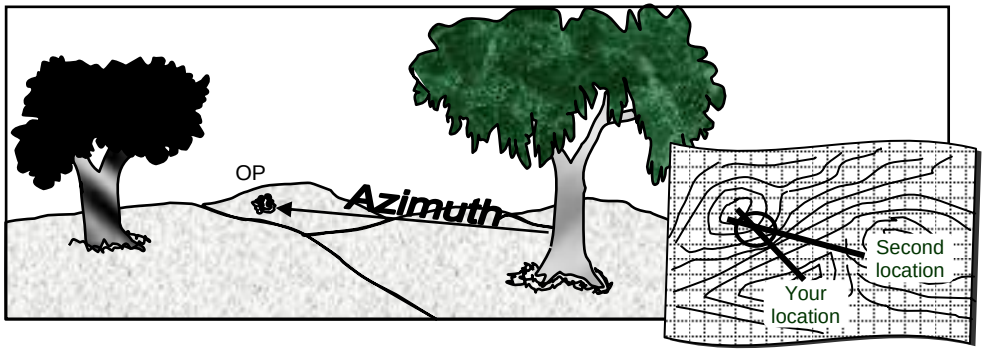

Figure 25. Intersection Process – Step 2

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DETERMINING RELIEF AND ELEVATION

Your military map shows something important that ordinary maps do not—relief and elevation (the slopes, hills, and valleys). You have already learned about locating points, measuring distances, and finding the right direction. But, you should also check hills and valleys along the direction you intend to travel before you start.

Relief is the representation (as depicted by the mapmaker) of the shapes of hills, valleys, streams, or terrain features on the earth's surface. Elevation is the vertical distance of a point on the earth's surface above or below sea level. There are several methods used by mapmakers to depict relief and elevation of the terrain.

Contour lines are the most common method used on standard military maps. A contour line is shown as a brown line that connects points of the same elevation. Each line depicts the height above sea level. Contour lines never cross one another.

Printed at the bottom of the map is the contour interval—the difference in height (elevation) between one brown line and the one next to it. On a map with a scale of 1:50,000, the contour interval is usually 20 feet.

Refer to Figure 26. Point A would be 80 feet lower than point B. You can determine this because every fifth line is heavier than the rest and has a number that gives its elevation. You could also get an idea of how steep the slope is if you knew the ground distance between point A and point B.

The rate of rise or fall of a terrain feature is known as its slope. Widely spaced contour lines show a gentle slope; closer contour lines show a steeper slope. You can tell from looking at your map what the slopes, hills, and valleys will look like on the ground.

NOTE: Look at the slope before following a valley. Close contour lines equal a steep slope.

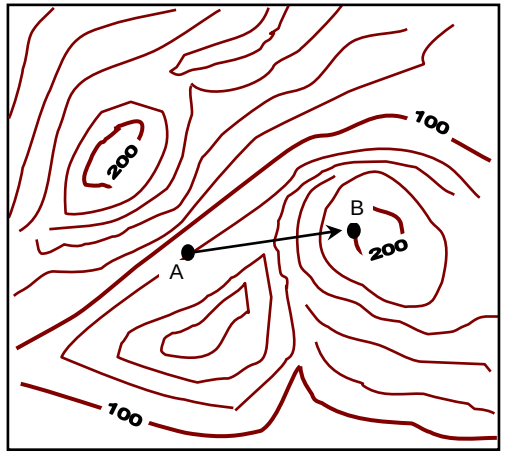

Figure 26. Contour Lines and Intervals

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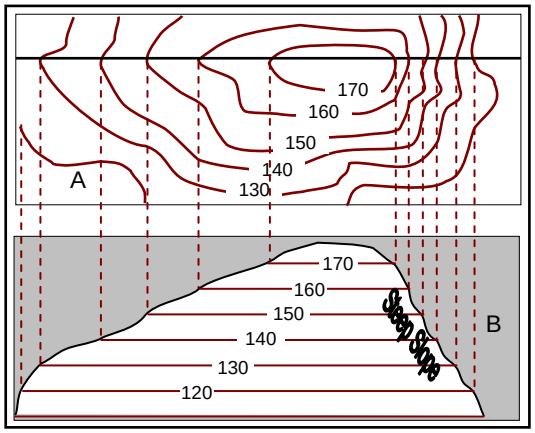

Figure 27. Determining Slope

Figure 27 shows how the same hill would look from the ground. Note that side A would be the easier side to climb.

Contour lines across a stream always come together in a V-shape (Figure 28).

When the contour lines are close together at the top of a hill, the hilltop is pointed. When the contour lines are widely spaced at the top, the hilltop is flat (Figure 29).

The legend on the map shows water as blue. To determine the direction that the water is flowing, look at the contour lines. The V-shape always points upstream or toward high ground. Looking for a stream is a good way to find valleys.

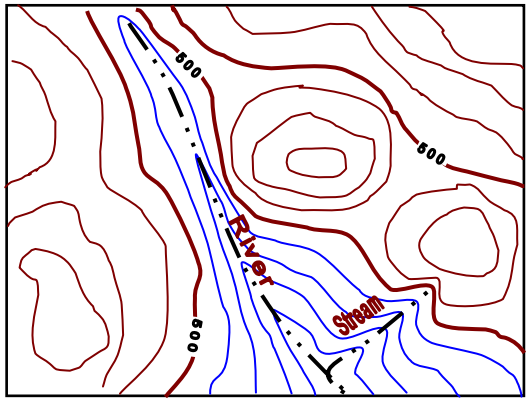

Figure 28. Stream

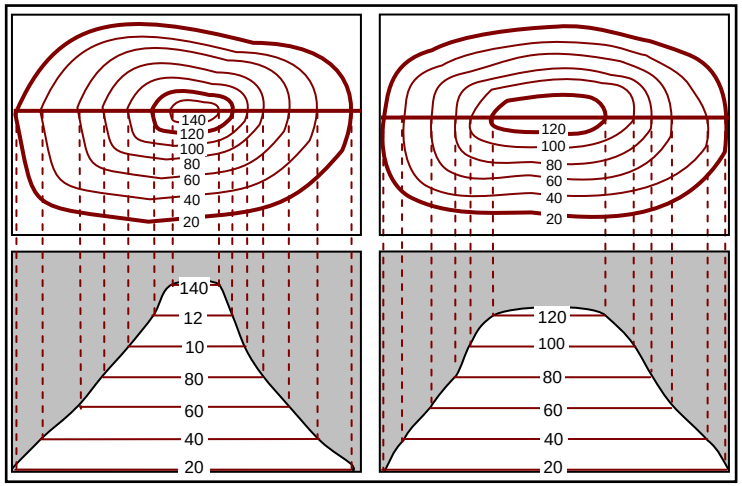

Figure 29. Hilltop Contour Intervals

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Sometimes contour lines show two hilltops fairly close together. The lower terrain between the two hilltops is called a saddle (Figure 30).

If you are in a saddle, there is high ground in two opposite directions and lower ground in the other two directions. A saddle is normally represented as an hourglass shape. Going through a saddle is sometimes the easiest route to use to get beyond the two hills. You would not want to go through a saddle if the enemy was on the hills.

Another terrain feature you should be familiar with is a ridge (Figure 31). A ridge is a fairly long, narrow section of terrain. If you are standing on a ridge, the ground will go uphill in one direction and downhill in the other three. Contour lines that form a ridge tend to be either U- or V-shaped. The closed end of the contour line points away from high ground. The path of the ridge, depending on your geographic location, may be either an almost unnoticeable slope or a very obvious incline.

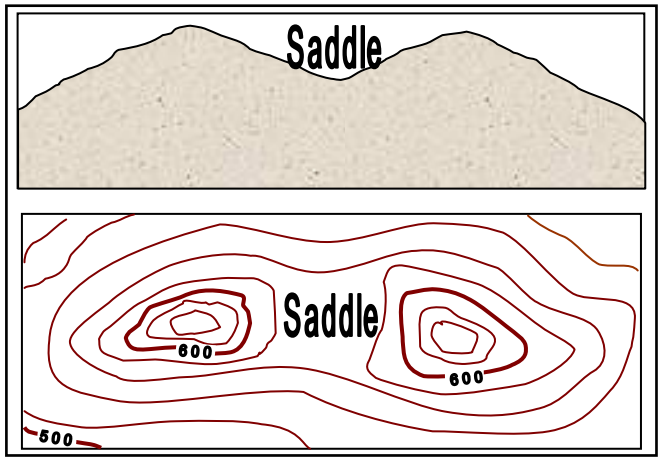

Figure 30. Saddle

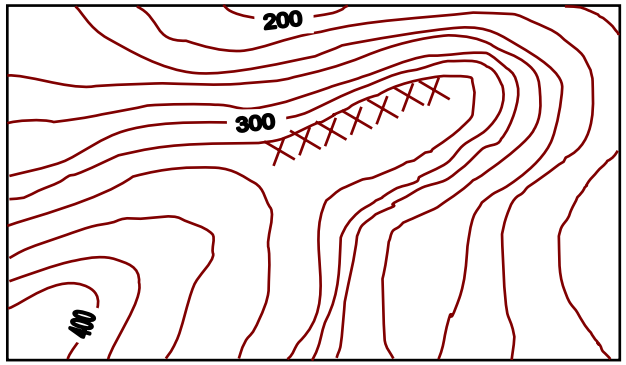

Figure 31. Ridge

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You can also use contour lines to determine the line of sight from one point to another. For example, you are at point A and you want to see point B. To determine the line of sight, draw a line from point A to point B on your map (Figure 32). Note that it crosses some contour lines with higher elevation than both points. Therefore, you know you will not be able to see point B.

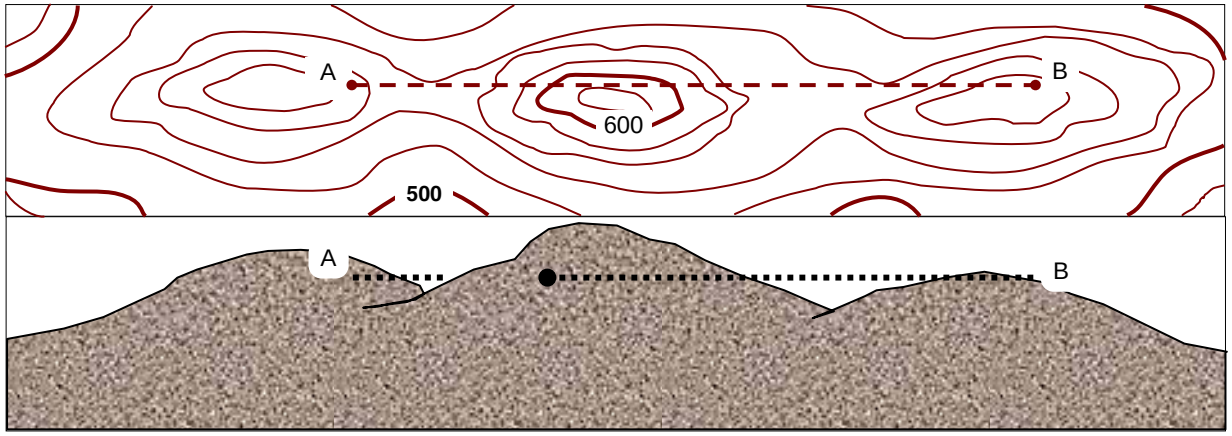

Figure 32. Determining the Line of Sight

CONCLUSION

You have learned from this booklet how to find your location and write it as a six-digit number coordinate. You have also learned how to measure distance, find directions, and read contour lines. If you use this information, you can avoid getting lost. Practice and review this information before you have to navigate. Do not wait until you are lost before trying to remember what you should already know about map reading and land navigation. Also, take time to review FM 3-25.26.

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